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Phase II Advanced Fuel Additive and Sensor Development

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1. Year II Technical Objectives

The scope of this project is to evaluate different fuel additives and formulations that will assist the Navy in meeting the performance and environmental requirements of the future. The project will also include development of a system to monitor the key parameters to ensure that the requirements are being met. The project will include analysis and lab testing of various commercially available marine additives, the development of monitoring capabilities, then the testing of the formulations on a marine diesel at a land based test facility.

The alternative fuel tests, to be conducted under this program, would prove the following in laboratory and land based engine tests with the Navy's most used engine types (2 stroke and 4 stroke diesel engines and combustion gas turbines):

- Reduced engine exhaust emissions of oxides of nitrogen and particulate matter,
- Acceptable engine power output,
- Acceptable fuel consumption,
- Acceptable fuel physical properties,
- Acceptable engine and fuel system mechanical life (wear, corrosion and deposits).

This effort will develop a fuel emissions monitoring system to complement and demonstrate the value of fuel additives. This proposal addresses the phase of effort, which will move from concepts to land-based prototypes.

Specific Year II objectives include the completion of steps 4 – 8 of the Fuel Additive Development Way Forward developed in Year I:

1. Develop fuel additive/alternative fuel database
2. Develop coarse matrix – coarse screen
3. Laboratory tests – fine screen
4. Land-based testing
5. Shipboard Testing Plan Development

Specific Year II objectives also include the completion of steps 4 – 9 of the Fuel Quality Monitoring Way Forward developed in Year I:

1. Design a shipboard fuel quality sensor suite
2. Develop wireless concepts
3. Prepare Wireless Working Paper
4. Develop a fuel quality sensor test plan
5. Develop fuel quality diagnostics and prognostics
6. Prepare Fuel Quality diagnostics/Prognostics Working Paper

2. Status Report

2.1 Fuel Additive Development

2.1.1 Fuel Additive Database

The IPT performed market research on commercially available fuel additives. Based on this market research, a database of potential fuel additive suppliers was developed. The initial database was been finalized and was placed on ICEPak under ONR Fuel Additive Program/Fuel Additive/Database Development/Application.

2.1.2 Fuel Additive Course Matrix/Course Screen

Using information originally obtained from the market research, the team developed a questionnaire to send out to all vendors. The questionnaire was designed to ensure complete, accurate, and consistent information was obtained from all vendors to support a fair and accurate comparative analysis of all vendor products identified in the market research. The questionnaire was sent to all vendors identified in the Fuel Additive Database and the vendor responses have been placed on ICEPak under ONR Fuel Additive Program/Fuel Additive/Database Development/Analysis.

A course evaluation matrix was developed and used to score the vendors based on their responses to the questionnaire. The evaluation matrix and scoring results have been placed on ICEPak under ONR Fuel Additive Program/Fuel Additive/Analysis. A write up on the scoring matrix has also been placed on ICEPak under ONR Fuel Additive Program/Fuel Additive/Reports. Based on the course screen, four additives and two add-on devices were selected for laboratory testing.

2.1.3 Fuel Additive Laboratory Testing

The four additives and two add-on devices selected through the course screen process were tested in the fluke/oil analysis laboratory at Pax River. The results of laboratory testing have been placed on ICEPak under ONR Fuel Additive Program/Fuel Additive/Additives/Test. These results will be summarized in the project final report to be completed during the next period. Based on the lab results, two additives and the two add-on devices were selected for live engine testing in both a gas turbine and a diesel engine.

2.1.4 Fuel Additive Live Engine Testing

Based on the lab results, two additives and the two add-on devices were selected for live engine testing. Gas turbine testing was conducted using the gas turbine test stand at Pax River. The goal of the testing was to determine performance effects, especially emissions performance of the selected additives and add-on devices. The gas turbine testing is complete, however, analysis of the results is not complete or posted to ICEPak yet. The diesel engine testing will be conducted at NAVSSES Philly. The results of this live engine testing will be summarized and either incorporated into the Fuel Additives Working Paper or prepared as a separate test report.

2.2 Fuel Quality Monitoring

2.2.1 Fuel Quality Monitoring Sensor Suite

Building on the Sensor Working Paper developed under Year I, the IPT continued development of a fuel quality monitoring sensor suite. A major goal of the suite design was to be able to analyze fuel quality while eliminating the need for sample bottles on the ship. The sensor suite design and specification was completed during this period and was incorporated into the Sensors Working Paper. The paper is in ICEPak under ONR Fuel Additive Program/Sensor Development/Report. Revision 4 is the current version of the document.

2.2.2 Wireless Concepts

The IPT continued work on wireless concepts to support the shipboard sensor suite. A major goal was to support the seamless transmission of fuel quality data while eliminating the need for an operator to manually record or manually transfer any sample results. A section on wireless concepts was incorporated in the Sensors Working Paper Rev 4 to avoid the creation of a separate document. The paper is in ICEPak under ONR Fuel Additive Program/Sensor Development/Report.

2.2.3 Fuel Quality Diagnostics and Prognostics

The IPT completed the sensor failure matrix and incorporated diagnostic/prognostic concepts into the Sensors Working Paper Rev 4, as was done for wireless concepts, rather than create a separate working paper. The paper is in ICEPak under ONR Fuel Additive Program/Sensor Development/Report. The concept section includes incorporation of information from the JP-5 Maintenance Final Report (a report prepared under a separate contract which the team has been given permission to use to support the working paper).

2.2.4 Fuel Quality Monitoring Advanced Sensors

The fuel quality monitoring sensor suite design was based on sensors currently available in proven applications. The IPT completed an evaluation of advanced sensor technologies that would improve the effectiveness of the sensor suite. These technologies represent fertile ground for future R&D efforts. The results of this evaluation and recommendations for future efforts are currently in draft form and will be added to the Sensors Working Paper. The draft is in ICEPak under ONR Fuel Additive Program/Sensor Development/Report.

2.3 Fuel Quality Monitoring BAA End of Year Report

A summary report of the 2nd year activities under this BAA contract was placed on the ONR End of Year web site.

3. Schedule and Milestones

The following milestones were completed this report period:

- Develop Diagnostics and Prognostics Concepts
- Draft Advanced Sensor Evaluation
- Conduct Gas Turbine Live Engine Testing
- Coordinate Diesel Engine Live Engine Testing

The following milestones are scheduled for completion next quarter:

- Conduct Diesel Engine Tests
- Prepare Live Engine Test Results Report
- Finalize Advanced Sensor Evaluation
- Prepare Final Report for Task